

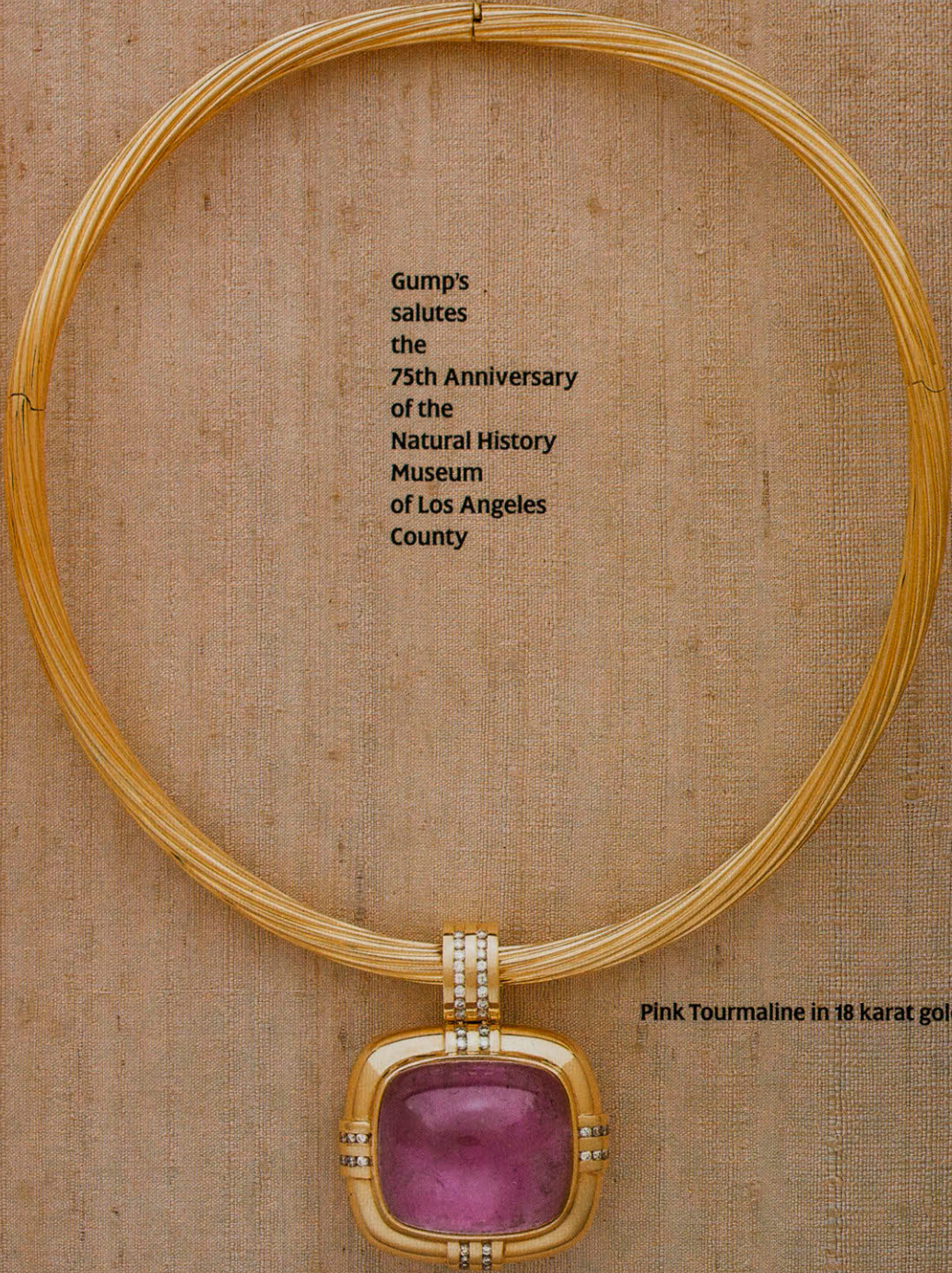


TERRA

THE NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY

VOL. 25, NO. 4, MARCH/APRIL 1987

Special Issue
Gold: The Quest for
New World Riches



Gump's
salutes
the
75th Anniversary
of the
Natural History
Museum
of Los Angeles
County

Pink Tourmaline in 18 karat gold with diamonds

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TERRA

THE MEMBERS' MAGAZINE
OF THE NATURAL HISTORY MUSEUM
OF LOS ANGELES COUNTY
AND THE PAGE MUSEUM
OF LA BREA DISCOVERIES

VOL. 25, NO. 4 • MARCH/APRIL 1987



COVER: These gold coins, recovered from Spanish treasure ships lost off the coast of Florida, are on loan to the Natural History Museum for its exhibition *Gold: The Quest for New World Riches*. This exhibit will also feature gold in its natural state, many Pre-Columbian gold artifacts, and gold objects associated with the history of the New World. See page 4 for more exhibit information. Photograph courtesy of the Florida Division of Historical Resources.

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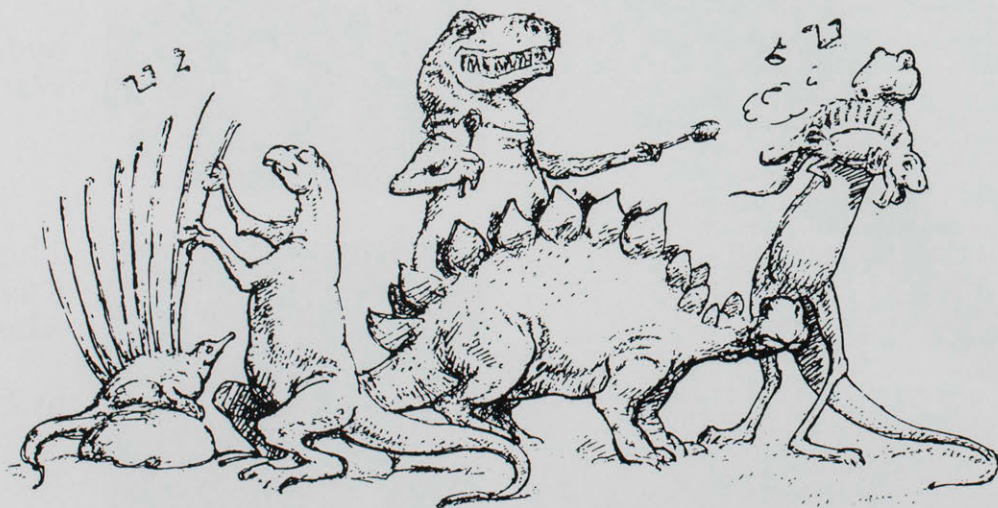
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THE QUEST FOR
GOLD
NEW WORLD RICHES

This exhibition has been made possible with support from the Gold Card® Division, American Express Travel Related Services Co., Inc.; the Precious Metals Investment Group, a Division of Security Pacific National Bank; Homestake Mining Company; with additional funding from Monex International. Travel arrangements by Avianca Airlines.

This major exhibition of gold from the New World, organized by the Natural History Museum and appearing nowhere else, will be on display at the museum March 7 through May 17, 1987. Tickets to this special presentation are \$4 for adults and \$2 for senior citizens and full-time students with I.D.; children under 12 are free with a paying adult. Tickets are on sale at the Data Management Office in the museum's Rotunda (Tuesday-Sunday, 10 a.m.-5 p.m.), at Ticketmaster outlets including all May Company and Music Plus stores, or may be charged by phone through Ticketmaster by calling 213/480-3232, 714/740-2000, 619/232-0800, or 805/583-8700. There is a \$1 service charge for each ticket and a \$1 handling charge for each ticket order except for those tickets purchased in person from the museum's Data Management Office. The exhibition will be open from 10 a.m. to 5 p.m., Tuesday through Sunday.

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GOLD SPELLS SUCCESS

by JANET R. FIREMAN

Golden anniversary. Gold medal. Gold cup. Golden Spike. Little gold band. Heart of gold. Gilt-edged stock. Gold watch. Gold doubloons. Golden oldies. Gold record. Gold standard. Golden Globe. Gold star. Golden west. Golden Gate. Golden touch. Solid gold Cadillac...or gold Rolls Royce.

Gold is used in many ways in our society, and it is not hard to compile a list of examples. Even a child could do it, for we are taught the value of gold from a very early age. Not exactly the monetary value of gold, which is another very important use of gold, but the *symbolic* value of gold. Before she was enrolled in preschool, Whitney, a little friend of mine, pointed proudly to the chart on the refrigerator in her parents' kitchen. She showed me that next to her name there were more gold stars than silver or any other color. When I asked her what that meant, she puffed up as proudly as her thirty-pound body would permit and pronounced, "That means I'm a winner; it means I'm a good girl!"

Whitney, at three years of age, already knows that gold spells success. Whether used to measure success in picking up toys and putting them in the toychest, as in Whitney's case, or for other tasks and accomplishments in the adult world, gold has become a symbol of success all over the world.

"Go for the gold," the unofficial slogan for the U.S. Olympic team at the 1984 summer games, applies to all kinds of sporting events, to professional competitions, to treasure seekers since antiquity, as well as to personal ratings. It goes without saying that a gold star is the best a little child can receive for classroom or household tasks, and that a gold cup is the top prize in soccer, in horse, auto, or dunebuggy racing, or in hairstyling, real

estate sales, and countless other competitions. The famous Oscar, awarded for achievement in film is gold; the *Prix d'or* is the equivalent at the Cannes Film Festival. Gold medals represent the highest rank in such disparate undertakings as trade fairs, the Order of the Golden Fleece, and of course, at the Olympics. To top it all off, kings and queens wear crowns of gold.

The search for success in everyday behavior is also influenced by the symbolism of gold. When we are presented with a golden opportunity, we know we are fools not to follow up on it. Golden dreams represent our fondest hopes. Golden years are supposed to be the kindest, finest of times. A golden age is a historic period when all people enjoyed the benefits of prosperity, progress, and cultural achievement—an ideal toward which we strive. The golden mean is prudent moderation or the safe, comfortable, and secure way of approaching life's conundrums. The golden rule prescribes that we should behave to others as we would have them behave to us. Gold offers the best of the best; opportunities, wealth, success. "Go for the gold!" means "Win!" and that means SUCCESS.

Whereas gold has come to have the metaphorical meaning of something that is joyful, favorable, auspicious, or excellent, those connotations derive from the monetary value that has been accorded to the metallic chemical element in Group I of the periodic table of elements. Its symbol is Au, from the Latin *aurum*, which certainly does not seem like much in itself. Nevertheless, it stands for the best known and most highly valued (though not the most valuable) of the precious metals. Platinum costs more than gold, but is not nearly so important as gold. The unique combination of physical properties possessed by gold—its malleability, ductility, and perma-

nence—along with its rarity, account for its monetary value and also account for the wide variety of uses to which it has been put.

Most of the gold ever mined or imported into the United States—or anywhere else for that matter—is used for monetary purposes. For the most part, this gold is in the form of bullion which backs paper currency and serves as a measure of international payment balances. Approximately 90 percent of all U.S. gold exists as reserves, in the form of ingots or bars, most of which are stacked neatly and guarded at Fort Knox, Kentucky. This gold bullion depository was designated in 1935; gold began to be shipped there the next year. Since then, the federal hoards at the Philadelphia, San Francisco, and Denver mints, and at the Seattle, New Orleans, and New York assay offices, have been diminished by deposits to Fort Knox, located in the middle of a military reservation in the interior of the country.

Until the Civil War, the United States had been on a bimetallic standard, which means that a specified amount of silver or gold made up the value of a dollar. Effects of the war interrupted the system, and for over a decade a depreciated paper money standard prevailed. In 1873, the U.S. adopted the gold standard, whereby the gold dollar was the unit of value, there was a free market for gold, and the metal could be imported and exported without restriction. A gold dollar contained 23.22 grains of pure gold, and since there are 480 grains in one troy ounce, an ounce was worth \$20.67. By the early 1930s, there were 1.2 billion gold dollars in circulation. In 1934, we went off the gold standard, and a new type of monetary system was established. Since then, gold no longer circulates as coin, and the dollar is based on a reduced gold weight varying between 50

Continued on page 8

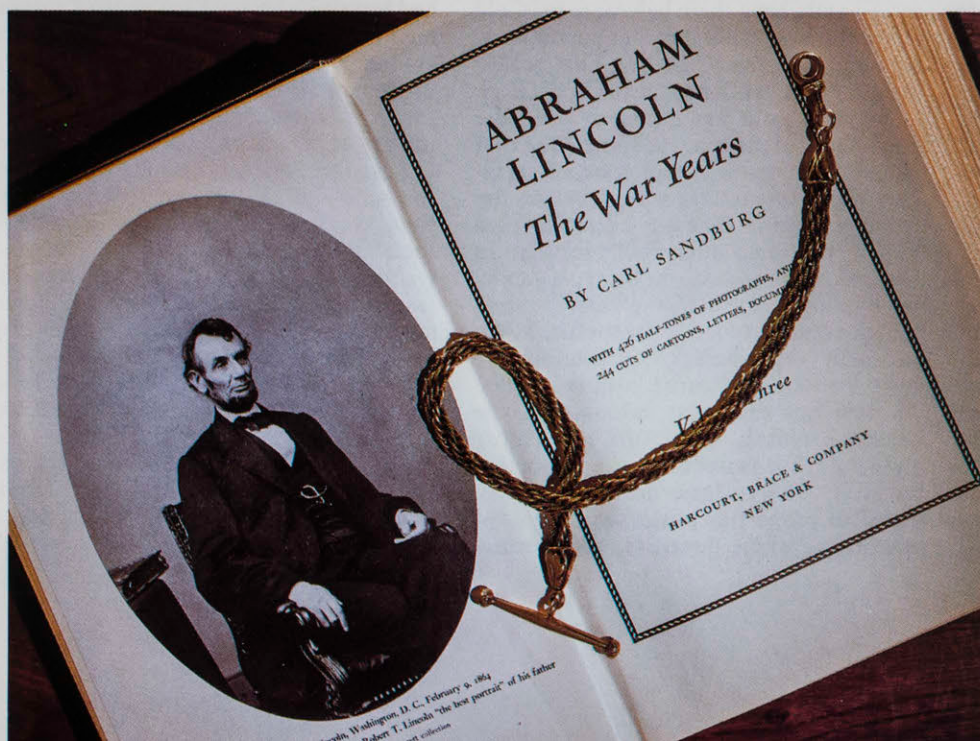
Metal coins have been used for thousands of years, and various shapes of bullion bars have been the means that governments have usually used to store precious metals. In the last few years, a dramatic new interest in gold coins, as legal tender and as bullion, has led to the minting of pieces by the United States, Australia, Luxembourg, Austria, China, Mexico, South Africa, and Canada. Photograph courtesy of Intergold.

Right: Jewelry is still one of the main uses for gold, as its beauty and durability make it ideal as a precious metal or as a fitting or accompaniment to precious and semi-precious stones. This modern selection of pearls and citrines set in gold is from the holdings of Gump's of San Francisco and Beverly Hills, one of the leading firms on the continent, and one with a long California tradition. Photograph by Don Meyer.



Perhaps one of the most valuable artifacts associated with Abraham Lincoln is this gold watch chain, presented to him in 1863 by the California congressional delegation. Lincoln biographer Carl Sandburg praised the workmanship and claimed that modern craftsmen could not duplicate the piece. Photograph by Dick Meier.

Right: William S. Hart was one of the earliest Hollywood stars. His many cowboy roles set the pattern in the silent era for Westerns and adventure stories on the screen. This selection of gold bibelots is from Hart's extensive personal collection. Although he owned precious stones and Indian jewelry of the American West, he was partial to gold, as this photograph illustrates. Photograph by Don Meyer.





and 60 percent of the value of our former gold gollar. Gold remained at about \$35 an ounce until 1968, when the price increased substantially. Upward fluctuations in the value of gold have taken place with some frequency since then.

In October 1986, for the first time in fifty-three years, the Treasury issued a new legal tender gold coin, the American Eagle. Available in denominations of \$5, \$10, \$25, and \$50, the coins carry a depiction of Liberty on one side and the American Eagle on the other. But the coins are not for circulation at their nominal values; they are priced at the current rate for gold by weight, plus a handling fee. Each coin, then, is worth far more than its nominal (face) value. The American Eagles are suitable for collecting—for the pure pleasure of owning gold—or for the sake of investment and speculation.

Several other nations issue gold coins for collectors and investors, some of which are made into jewelry; far more are hoarded as personal reserves to back up individuals' wealth. Among them are the Canadian Gold Maple Leaf coins, which are minted in four sizes ranging from one-tenth to one ounce. Until recently, the most popular of all are the gold coins of Mexico, with over 75 million individual coins sold in nine denominations ranging from .0482 to 1.2057 troy ounces in weight. Other gold coins include the South African Kruggerand, the Chinese Panda, the Austrian Corona, and the recently released Australian Nugget. Collectors and investors also accumulate bars and medallions and pieces (round commemoratives that look like coins) in a variety of sizes, made by Engelhard Industries and other manufacturers.

The approximately 10 percent of gold that is not used in bullion and controlled by the U.S. government is employed in a broad spectrum of applications, from dentistry to space helmets to architecture. The greatest proportion—about 125 tons in an average year—is taken up by what is probably the most obvious, and certainly the most familiar use: jewelry. However, you might be surprised to know that class rings account for one-third of all jewelry manufactured in this country (forty tons each year), followed by wedding and engagement rings as a runner-up (thirty tons), and then by a miscellany of necklaces, bracelets, pins, rings, cufflinks, earrings, and other glittering baubles. Except for class rings, which are usually made of ten karat gold, most jewelry in the United States is fourteen karat. Pure gold is twenty-four karat, but it is too soft for practicality. Alloys of specific amounts of several metals result in gold of twenty-two,

eighteen, fourteen, or ten karats, with variations in color depending on the alloy. White gold is created by adding silver and nickel or palladium; red gold by adding copper; greenish gold by adding copper and silver or nickel and palladium; and a much yellower golden gold by adding a mixture of copper and silver.

Gold jewelry used to be entirely handmade, but like so many other products, this has changed with technological advances. Large companies now produce various gold shapes in bulk and sell these to manufacturers who combine gold wire, sheets, and tubes to crank out treasure troves of chains, rings, and charms of seemingly endless variety. Italy is the world leader in mass-produced jewelry, which is exported to many other nations. Although the gold jewelry that most of us wear is the result of mass production, there are still many individual goldsmiths and larger enterprises that specialize in fine design and hand-crafted gold jewelry. Cartier in Paris, Bulgari in Rome, Tiffany in New York, and Gump's in San Francisco are among those with the shiniest credentials.

Yet another use of gold with which many of us have intimate daily contact is in dentistry. The humblest of men is made a king when his dentist fits an individually cast crown to a tooth. Some twenty tons of gold per year are made into crowns by American dentists, and another fifty tons or so are used worldwide. In its current advertising campaign plugging eighteen karat gold jewelry, the Gold Information Center says, "Nothing else feels like real gold." This may be true of jewelry too, but for every person just walking out of the dentist's office after receiving a first gold crown, there is absolutely no doubt about the claim. Nothing else could feel so clean and slick and solid to the tongue as that fine twenty-two karat crown now replacing a jagged and painful gap. Yessir, good as gold!

Industrial and decorative uses of gold are two sometimes related major categories of gold application. A flashy, yet practical use of gold is in architecture. The Richfield Oil Company made history and the skyline glow in 1929 when its new headquarters in downtown Los Angeles was covered with a thin ceramic veneer of gold. For the relatively low cost of \$12,000, Richfield set a style that was imitated later on a number of buildings. Although the Richfield building was demolished in 1968, many other gilded structures still gleam in the Los Angeles and Beverly Hills sunshine. Besides the obvious aesthetic advantages, gold serves several other purposes well. It never oxidizes and therefore is easy to clean, it reflects heat and there-

fore is a natural insulator, and it is durable and therefore protects the underlying surfaces and needs no repair itself. Windows coated with a liquid gold solution, or glass in which tiny gold specks have been incorporated, also serve as reflectors of heat and to eliminate glare.

The electronics industry is the most important single example of the industrial use of gold. Because of its low resistance and excellent conductivity, gold is ideal as a connector in tiny relay mechanisms used in cables, satellites, and other communications equipment. Copper overlaid with liquid gold is used in the electronic circuitry of computers, color televisions, and the many other electronic miracles that have become necessities in the past decade or two.

In the space industry, gold has become an irreplaceable and precious construction material. Gemini and Apollo spacecraft contained gold as a shield for heat and thermal radiation, astronauts' umbilical cords for space walks are coated with gold, and the visors on their helmets are golden for the same reasons. Jet fighter, Concorde, and rocket engines are covered with a thin film of gold for insulation. In air and space travel vehicles, and in electronics, the use of gold has increased to such an extent in the last twenty years that it has surpassed the amount inserted into American and western European teeth, formerly the second largest user after jewelry.

Besides gold's decorative uses in jewelry and on buildings, there is one further glistening category that must be added to the list. As artistic ornament, gold has been employed for centuries as gilding on paintings and picture frames, book pages and bindings, on furniture, and on silver. A variety of processes has been used to create silver gilt, or vermeil. Liturgical vessels and an endless variety of flatware and table holloware; pens, pencils, and other desk accessories; and personal accoutrements such as combs and brushes, toothpicks, calling cards, and even chopsticks continue to be made by gilding or goldplating. Because gold can be beaten thinner than any other metal (four-millionths of an inch thick), the most precious metal is often used as gilding in the form of gold leaf on more common substances, such as wood, paper, and porcelain. Its advantages are many: it stays bright almost forever, it has the real, soft, warm luster of gold, it is inexpensive, and it lasts a very long time.

Gold leaf is applied to picture frames, furniture, and other wooden objects after layers of gesso have been applied to the wooden base and carved to the desired shapes. Size, or glue, is brushed on, and once it is dry, a shallow layer of water serves as base to the gold leaf, which is

Man's quest for gold has also led him to find uses for the yellow metal that are indeed other-worldly. The Apollo astronauts used personal equipment that included gold, and portions of the lunar model also contained gold. The plastic visors of the Apollo helmet have a thin film of gold that has been applied by thermal evaporation in a vacuum. The gold reduces glare from sunlight, thus permitting better visibility. The Apollo television camera and batteries have similar gold coatings, which maintain them at even temperatures. Photograph courtesy of the National Air and Space Museum.

burnished painstakingly with a smooth stone or animal's tooth. Similar processes are followed for gilding miniature paintings on manuscripts, for decorations on leather or cloth bookbindings, or for roof domes, such as the one on the California state capitol. Gold suspended in a paste, powder, or liquid is applied with a fine brush to porcelain table service, vases, statuettes, and other bibelots. Articles produced at Meissen, Limoges, and Sèvres from the mid-eighteenth century onward are the best known and most often imitated of this style of gold ornamentation.

Gold braid and thread, used as sparkling adornments to uniforms for epaulettes and lapel trim, and for fine needlework, tapestries, and other textiles, are still further examples of the artistic application of gold. The malleable and ductile nature of gold is applied to its greatest advantage in the manufacture of gold thread, where only six grains of gold (one-eightieth of an ounce) are extended to a mile's length of thread.

Where an ounce of gold can be spun into eighty miles of the richest thread, where just a few ounces can be hammered into gold leaf that will cover a building with a permanent gleaming layer thinner than melted butter, where the finest of sprays of liquid gold can protect the astronauts and their equipment from solar radiation during exploration in airless space, the possibilities for the use of gold seem endless. That gold is called eternal, that it is invoked to characterize our most treasured hopes, dreams, and standards of behavior, that mystical and newly found medical powers have been ascribed to it, and that it is absolutely unparalleled in its versatility, and unequivocally universal in its attraction; all add up to an inescapable conclusion. Although gold is often imitated, it cannot be duplicated: it is *really* the real thing; gold spells success itself.

Dr. Fireman, head of the museum's Cultural History Section, has been powerfully attracted to gold since early childhood.

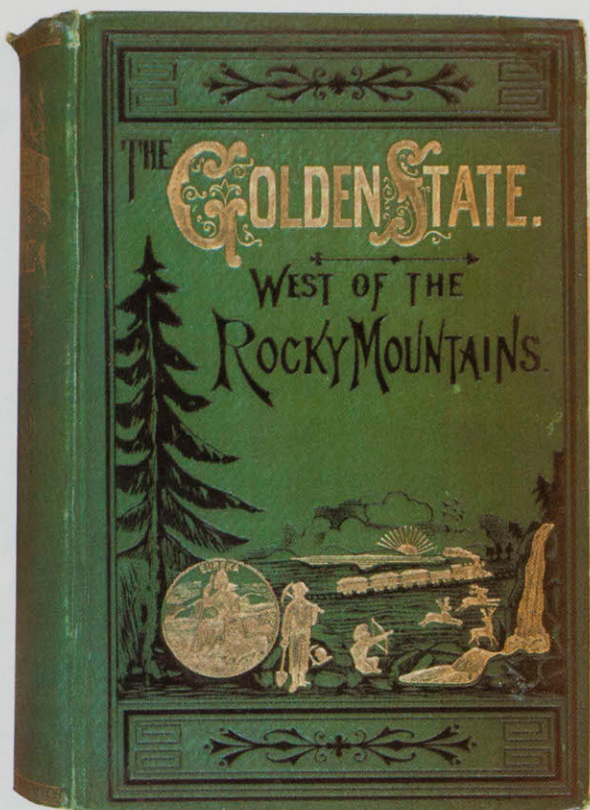


The tooling of leather for covering books began in the fourteenth century, and within a few hundred years the art of using liquid or powdered gold on leather was highly developed. The techniques of using heat, special pads, and rollers owe most to Arab and Persian craftsmen. By the nineteenth century, gilding of book covers and spines was commonplace, not only to emphasize beauty and color, but also to act as a preservative. Page ends were gilded for the same reasons.

Page 11: Gold has become a useful architectural ingredient. The metal never oxidizes and is a great reflector and protector.

Twenty-two karat gold is used on roofs and for door and window highlights. The gold is beaten thinner than butter, actually does not cost very much, needs little repair, and seldom needs cleaning. Many architectural historians consider the Richfield Building in Los Angeles the first effective use of gold as an ingredient rather than just an embellishment. The building was completed in 1928, but demolished in 1968. Photograph by Marvin Rand.

Below: The ancient Chinese method of gilding porcelain and pottery was simply to apply gold leaf over a layer of linseed oil or egg white or shellac. Several hundred years ago, European experiments led to the preparation of gold in powder form, which gradually replaced the old Chinese method. The permanence and brightness of gold appeal to designers, manufacturers, and clients. In modern times, more than five tons of gold are used annually in the decoration of porcelain and earthenware. A fraction of an ounce fashioned in a distinctive design makes this Limoges demitasse cup and saucer instantly recognizable. Photograph by Dick Meyer.





THE NATURAL HISTORY OF GOLD

by PETER C. KELLER



The largest existing gold nugget from California is this approximately 156-ounce (10 pound) specimen from near Mojave, California. From the collection of Wayne and Dona Leicht. Photograph © Harold and Erica Van Pelt.

The Occurrence of Gold in the Earth's Crust. Gold as a component of the earth's crust is not as rare a metal as zirconium or bismuth, for example, which we normally consider relatively common and not at all precious because they occur in large, concentrated deposits. Gold, conversely, is very widespread throughout the crust, but rarely occurs in concentrations that are high enough to recover at a profit.

It is estimated that gold makes up about 3.5 parts per billion of the earth's crust. Traces of gold are even found in sea water and in the ashes of plants and animals. It is found in small amounts in

all rock types, although igneous rocks (which are the product of magma, a fiery chemical solution that originates deep within the earth), particularly granites, have the highest concentrations. Igneous rocks rarely have concentrations of gold that can be recovered economically, but geologic processes associated with igneous activity give rise to our richest primary deposits, that is, deposits of gold formed directly from a crystallizing solution.

Gold deposits are crystallized when the magma, which consists of molten minerals, water vapor, gases, and small amounts of valuable minerals such as

gold and silver, cools deep within the earth. As it does so, water and other volatile substances may separate from the magma and escape to the surface. There, hydrothermal (hot water) solutions are the principle transporting agents for the world's rare elements, including gold. These hydrothermal solutions travel upward in the earth's crust to areas of lower temperature and pressure, filling available fissures and other openings in the rock until conditions of temperature and pressure are right for the gold and other minerals, usually quartz, to crystallize to form gold-bearing quartz veins. These primary deposits of gold,



Gold most commonly crystallizes into eight-sided crystals known as octahedrons. This brilliant 1-inch specimen from the Eureka Mine, Tuolumne County, California, exhibits unusually sharp octahedrons in parallel growth. Wayne and Dona Leicht Collection. Photograph © Harold and Erica Van Pelt.

called *lodes*, are relatively rare today.

Most of the gold mined today is concentrated into placer (secondary) deposits. Historically, the recovery of gold from the earth has taken little or no sophisticated technology. Wind, water, and gravity, acting on massive amounts of host rock, have, over millions of years, released the fine particles of gold and reconcentrated them into the placer deposits. Because gold is very dense relative to more common minerals such as quartz and feldspar, it will, once released from the host rock, become concentrated with other gold particles. Because gold is chemically inert, and cannot be dis-

solved by natural acids, and because it is very malleable, it tends to be hammered into nuggets rather than broken into small grains. If these nuggets are washed down a riverbed, they concentrate wherever the water slows: in potholes and pools near rapids and waterfalls or in the curves of meandering streams.

Placer gold usually forms flattened scales of differing degrees of fineness, the size depending partly on its original condition in the quartz veins and partly on the distance it has been transported and sorted by running water. Rolled masses of these gold scales are known as *nuggets*; the largest nugget ever found

was the 2,284-troy ounce "Welcome Stranger" nugget found at Black Lead, near Donolly, Victoria, Australia, in 1869.

While the search for gold continues, much of the "easy" gold present in streams or in veins near the earth's surface has been recovered by early prospectors. It is true that today's sophisticated mining technology has led to the discovery of many new, incredibly rich deposits, but most new technology is aimed at the "no-see-'um" gold, gold that is so fine that it cannot be seen with the unaided eye. These no-see-'um deposits are yielding massive amounts of



One of the finest specimens of crystal gold on matrix is this 3.3-inch high specimen from the Colorado Quartz Mine in Mariposa County, California. Photograph © Harold and Erica Van Pelt.

gold to satisfy the ever-increasing demands of the jewelry, electronics, and dental industries.

Because of its noble (indestructible) character, virtually all the gold ever mined throughout history still exists today. About 80,000 metric tons of gold have been mined over the past 6,000 years. Of this amount, about 2 percent was produced prior to 1492, 8 percent between 1492 and 1800, 25 percent between 1801 and 1900, and an astounding 65 percent between 1901 and 1975. If all this gold was refined to its highest purity, it would fill no more than thirty railroad

boxcars, make a two and one-half foot-thick slab the size of a football field, or a cube with fifty-three-foot sides. The total amount of gold produced in California is estimated to exceed 4,000 tons or enough to make a nine-foot cube.

Although in 1985 California produced only about 10,000 ounces of the precious metal, compared to the almost four million ounces it yielded in 1852, the gold prospectors have found new frontiers. The most recent gold rush has taken place in an area of Brazil known as Serra Pelada ("bald mountain"), located about 270 miles south of the mouth of the





Left: One of tens of thousands of Brazilian miners currently working at Serra Pelada, Brazil, where the most impressive modern gold rush is taking place. He is carrying a bag loaded with ore, which he will later search through for gold flakes and nuggets. Photograph by Harald Martes.

The "Fricot" specimen is named after the New York family who bought it after its discovery in 1865 and presented it to the California Division of Mines and Geology. This extraordinary 201-ounce (12.5 pound) mass of crystals was found at the Grit Mine at Spanish Dry Diggins, El Dorado County, California. It is one of the finest examples of native gold existing today. Photograph J. Patten, California Academy of Sciences.

Amazon River, where a farmer discovered a large nugget in January 1980. Since that time, over 40,000 independent miners have turned the mountain into a gaping hole and recovered a huge, as yet unrecorded, amount of gold.

The annual production of gold today is estimated to be over 38 million ounces. Approximately two-thirds of this gold comes from South Africa, which is the world's most important source of gold. The Soviet Union, with its rich Siberian placer mines, is thought to be the second-largest gold producer in the world today, although no accurate production

figures are available. Canada ranks third in production, followed by the United States, Ghana, and the Philippines.

Forms of Native Gold. Most visible gold that comes out of the ground occurs as stream-worn nuggets, as in the example on page 12, or as very fine dust, the result of millions of years of stream tumbling and battering. When gold is crystallized and is then retrieved directly from its pocket of formation, it can be at least as beautiful as the most stylish jewelry. It is quite appropriate that the early California gold miners referred to this relatively

rare form of gold as "jewelry" gold.

Gold occasionally, but very rarely, forms sharp, multifaceted crystals in vugs, which are open pockets in the host rock. Sharply developed gold crystals are rare, but when they do form, by far the most common crystal habit is the eight-sided bipyramidal octahedron, an example of which can be seen on page 13. Other forms and combinations of forms have been noted, including cubes and dodecahedrons. Crystals are rarely well formed; they are more typically distorted, flattened, or elongated in some way to yield branching aggregates and



This spectacular 5.5- by 6.5-inch specimen of leaf gold is characteristic of specimens recovered from the Red Lodge Mine in Nevada County, California. The remnant of a tree root still embedded in the specimen suggests the shallow depth at which this specimen was recovered. Wayne and Dona Leicht Collection. Photograph © Harold and Erica Van Pelt.

arborescent (treelike) groups. This branching is usually the result of repeated twinning along octahedral faces.

The first detailed description of gold crystals was undertaken by F. Alger in 1850, shortly after the advent of the California Gold Rush. Alger characterized these California crystals as "rather large, unmodified octahedrons with slightly depressed centers." These depressed centers are really a series of steplike planes, the result of the incomplete growth of a crystal. All crystals grow first and fasten on the edges. If growth is interrupted before the center "catches up," a *hopper* (depressed center) crystal results.

The finest crystallized gold comes

from a limited area near Midpines in Mariposa County, California. The most famous of several mines in the area that have produced fine specimens is the Colorado Quartz Mine. This mine produced exceptionally bright, well-formed octahedrons in treelike masses, usually found loose in clay-filled pockets. Occasionally these gold clusters were recovered still adhering to their white quartz matrix, as is the case with the specimen on page 14. These are considered to be among the finest gold specimens in the world.

Another California locality that has historically produced fine crystallized gold is the Grit Mine at Spanish Dry

Diggins in El Dorado County. It is from this mine that the famous 201-troy ounce "Fricot" specimen was recovered in 1861. This specimen, now in the collection of the California Department of Conservation, is a 12.5-inch (32-centimeter) diameter mass of relatively well-formed octahedrons up to three-eighths of an inch in diameter. It must be considered one of the world's finest (see page 15).

Not all gold found in a primary deposit will occur as crystals, however, since the pressure and temperature conditions at the time of crystallization and the space available to grow play an important role. Well-formed crystals generally require

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Why Is Gold So Special?

Just what is the soft yellow metal that has been called both "the motivator of conquering armies and voyages of exploration" and "the first of man's follies"? Why is gold so special? After all, gold is but one of the hundred-odd elements that make up the periodic table. Yet it is immediately set apart from most other elements because it is one of the few that may be found in nature in its pure state, uncombined with any other element (although it usually contains some silver). Native gold is prized beyond all other metals for its warm color, its low hardness (2.5 on the Moh ten-point scale), its high specific gravity, its marked malleability, and its resistance to attack by all common acids.

The properties of gold are so unique that chemists have dubbed it a "noble metal," a title that it shares only with silver and platinum. *Noble metal* refers to the material's high strength, extreme rarity, and outstanding resistance to corrosion and oxidation, which cause other base metals, such as iron, copper, and tin, to disintegrate. Even silver will tarnish and be attacked by acids. Gold is virtually insoluble in all acids except the combination of hydrochloric and nitric acids that is aptly called *aqua regia* or "royal water."

Because gold is so malleable, it will bend rather than break. One ounce of gold can be beaten into an ultra-thin translucent sheet almost one hundred feet square. It is also extremely ductile, which means that the same ounce of gold can be drawn into a thread over fifty miles long.

Gold is also very heavy. Pure gold has a specific gravity of 19.3, that is, it is 19.3 times heavier than an equal volume of water. Quartz, the mineral with which it is most commonly found, has a specific gravity of only 2.64. This great disparity is the key to gold's secondary accumulation into economically exploitable deposits.

Gold is also one of the most effective conductors of both heat and electricity, making it especially useful in technological applications. It is such an excellent conductor of electricity that a microscopic circuit of gold printed on a strip of plastic can replace miles of wiring in a computer.

The purity of gold is measured in terms of karats, with pure gold assigned the designation of 24 karats; thus, gold that is half pure and half composed of some other element such as silver or copper is designated as 12-karat gold. Gold can also be rated in terms of *fineness*, which is defined as "the proportion of pure gold in the same in parts per thousand." Twenty-four karat gold is given a value of 1000 fine, although in reality there is no such thing as 1000 fine gold; the purest gold available is 999.99 fine, because there are always some impurities present.

The fineness or purity of gold is reflected in its color. Pure gold is a warm, rich yellow color. Gold most commonly combines with silver, and the more silver is present, the lighter the tone of yellow. Gold may also combine with copper, which will give gold a reddish cast. In nature, gold is often found in the native state as a natural alloy with silver, copper, or one of the platinoid metals. The most common natural alloy is electrum, which is an alloy of at least 20 percent silver combined with gold.



The rarest form of gold is wire gold, and the finest examples of wire gold have been recovered from a single pocket at the Groundhog Mine in Gilman, Colorado. This 1.9-inch specimen, from that pocket, is part of the collection of the Los Angeles County Museum of Natural History. Photograph © Harold and Erica Van Pelt.

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low temperatures and pressure, and, most important, ample room in which to grow. As a result, gold may be found in its primary veins as formless masses, or "sponge" gold, if conditions were not ideal for slow crystallization. If conditions were ideal, but the only space available was a narrow fracture in a rock, then treelike masses, or bright, highly reflective leaves, may form, filling all available openings (see page 16). Because these leaves would have formed complete crystals if the space had been wide enough, the surfaces of the leaves are commonly covered with triangular-shaped ridges called *trigons* that repre-

sent potential octahedral crystal faces. If the fracture-filled enclosing quartz is dissolved, either naturally or with the help of hydrofluoric acid, beautiful free-formed leaves remain. These can be very desirable to the specimen collector.

The rarest form of native gold, much rarer than large well-formed crystals, is wire gold. Wire silver, which is relatively common, forms from the decomposition of silver minerals such as acanthite (Ag_2S). The free silver is literally extruded, much like toothpaste from a tube, and forms striated horns. Gold behaves in many ways like silver, and we believe that wire gold is formed in much

the same manner. Wire gold specimens are exceedingly rare. The most famous come from a single pocket discovered at the Groundhog Mine at Gilman, Colorado, in the late nineteenth century. The finest of a half-dozen specimens recovered to date is now in the Harvard University collection. The Natural History Museum of Los Angeles County is very proud to have a similar specimen, shown on this page, in its collection.

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HIS HIGHNESS HAS NEED OF GOLD:

Spaniards, Indians, and Gold in Colonial Latin America

by JOHN FISHER and
WARWICK BRAY

The Spanish Quest for Gold,
1492–c. 1600

"I spoke one day with Mutezuma and told him that Your Highness had need of gold. . . . When all was melted down that could be, Your Majesty's fifth came to more than 32,400 pesos de oro, exclusive of the gold and silver jewelry, and the featherwork and precious stones and many other valuable things which I designated for Your Holy Majesty and set aside; all of which might be worth a hundred thousand ducats or more. All these, in addition to their intrinsic worth, are so marvelous that considering their worth and strangeness they are priceless. . . . All the things of which Mutezuma has ever heard . . . they have modeled very realistically, either in gold and silver or in jewels and feathers, and with such perfection that they seem almost real. He gave many of these for Your Highness, without counting other things which I drew for him and which he had made in gold, such as holy images, crucifixes, medallions, ornaments, necklaces, and many other of our things."

*(Hernando Cortés to the
Emperor Charles V,
30 October 1520)*

By 1519, when Hernando Cortés and his six hundred followers began their march from Veracruz to Tenochtitlán, the pattern for expeditions into newly discovered territories had been established during almost three decades of conquest in the islands of the Caribbean, the coast of Venezuela, and Central America. To Cortés and his men, the quest for gold was of paramount importance, both to ensure their own personal wealth

and to enable them to retain the favor of the Spanish crown to which one fifth (or "quint") of all precious metals, whether obtained by the melting down of gold artifacts or by prospecting, was periodically remitted. The sensitivity displayed by Cortés in 1520 toward the distasteful idea of melting down the almost indescribably beautiful gold objects that he obtained from Montezuma, the Aztec emperor, was undoubtedly well-founded—this was the treasure that Albrecht Dürer described as "more beautiful than the things of which miracles are made" when he saw it on display in Brussels in 1520—but every single piece was eventually melted down for the bullion-hungry treasury of the emperor. What was surprising, perhaps, was not that the Spanish crown continued after 1520 to pursue its policy of using all the American gold provided by its fifth as a commodity without aesthetic significance, valuable only as a means of financing its European wars, but that the hard-bitten Cortés, the man who had rejected an offer of land on his arrival in Hispaniola in 1504 with the immortal declaration, "But I came to get gold, not to till the soil like a peasant," finally realized in Mexico that native gold objects were truly "priceless."

Very few gold objects from the Antilles survived the first three decades of Spanish colonialism. Like most of the native peoples who had produced them, countless nose-plugs, bracelets, and necklaces had disappeared by 1520 in face of an insatiable Spanish desire for bullion. Christopher Columbus himself, although often depicted as somewhat less materialistic than many of the conquerors who sailed for the New World in his wake, set the tone from the outset. His entry in his journal for October 13, 1492, the day after his "discovery" of the

Bahamas, emphasized the significance of the search for native gold:

"And I was attentive and sought to learn whether they had gold and I saw that some of them wore a small piece suspended from a hole they have in the nose: and I was able to understand by signs that, going to the south . . . there was a King who had large vessels of gold and who had a great deal of it."

The legendary Cipangu (Japan) and Cathay (China), for which Columbus continued to search until his death in 1506, lay farther to the west, he believed, but he decided immediately in 1492 to defer the quest for his fundamental objective and, in the light of the Bahamian Indians' information, "resolved to go to the south-west, to seek the gold and precious stones." The island of Cuba, which he found by taking this new course, proved, in fact, to be something of a disappointment, but prospects brightened on the north coast of Hispaniola. There the explorers not only obtained gold nose ornaments and bracelets from the natives, but also discovered a river that yielded sand "all full of gold, to such an extent that it was a marvel, although very small." Some grains, however, were "as large as lentils," and Columbus predictably named the source of this wealth Río del Oro, "River of the Gold."

Following further discoveries of placer (river) gold by a party sent to the interior of Hispaniola, Columbus set out for home in January 1493 to inform Ferdinand and Isabella, the Spanish sovereigns, of his and their good fortune. By April he had reached Barcelona, where the court was in residence, and was able to show the sovereigns gold plates and jewelry to back up the written report in his first letter that:

"In this Española...is the best district for the gold mines and for all the trade both with this continent and with that over there belonging to the Great Khan, where there will be great trade and profit."

His reference to "mines" was strictly inaccurate, for it appears that nearly all pre-Columbian gold throughout the Americas was obtained from placer deposits. The gold objects he was able to display persuaded the crown that Hispaniola could rapidly be turned into a self-sufficient, gold-producing colony. By September 1493, only six months after his return, Columbus was ready to set out again with no fewer than twelve hundred settlers, including artisans and miners.

Like Ferdinand and Isabella, Columbus was never able to resolve satisfactorily the fundamental contradiction involved in the twin quest for gold for profit and natives for conversion, particularly when it became abundantly clear that the first was rapidly reducing the availability of the second. The nearest he came to reconciling the two objectives, at least to his own satisfaction, was his 1503 observation, contained in a letter written to the Crown from Jamaica, that:

"Gold is a metal that is most excellent above all others and of gold treasures are formed, and he who has it makes and accomplishes whatever he wishes in the world and finally uses it to send souls into Paradise."

He supported his argument with somewhat obscure biblical references, taken from the Book of Chronicles and the Book of Kings, to David's gift of gold to Solomon to aid in the building of the Temple. Perhaps of greater interest to his correspondents was his somewhat puzzled further observation: "When the lords of those lands which are in the district of Veragua [Panama] die, they bury the gold which they have with the body; so they say."

Throughout the New World, the Spanish quest for gold, whether in the form of artifacts, nuggets, or dust, was facilitated by the fact that the metal had no monetary value for the indigenous peoples until it became an item of trade with the invaders. This provoked mutual incredulity among both conquerors and conquered, as Peter Martyr's 1530 account of Columbus's second voyage to Hispaniola, Jamaica, and Cuba (1493-96) indicates:

"One old man only asked a little bell in return for two grains of gold weighing an ounce. Seeing that the Spaniards admired the size of these grains, and quite amazed at their astonishment, he explained to them by signs that they were of no value....It is now known that the islanders set no value on gold as



Above: Eagle pendant. Veraguas-Gran Chiriquí style, Panama, 9.5 cm. (3.7 in.) high. The tail has a small hole where liquid metal failed to fill the lost wax mold. Cracks nearby indicate that the smith hammered the tail without sufficiently annealing it, perhaps to close the hole. The enriched gold surface is worn off the beak from use. Wrinkles show that the tips of the tail, and possibly the wings and body, were once folded up in an act of ritual destruction. Photograph by Don Meyer.



Left: Muisca tunjo, Colombia, 6.7 cm. (2.6 in.) high. This Muisca (also called Chibcha) piece retains the excess metal left when a smith poured liquid metal into the funnel-shaped opening of a lost wax mold. The position of the bead of excess metal indicates that the tunjo was cast with the head down. This tunjo, which was used as a votive offering, depicts a woman holding a ceremonial baton. Photograph by Don Meyer.

Top right: Chimú-Sicán corpse mask, Peru, 23 cm. (8.9 in.) wide. The holes around the outside edge of this mask were probably used to sew it onto a corpse bundle. The mask is made of three sheets joined mechanically rather than soldered. Traces of red paint are still visible in a T shape across the eyes and down the chin. Photograph by Don Meyer.

Below right: Chimú keros (cups), Peru, 19.5 cm (7.9 in.) and 13.7 (5.4 in.) high. Raised from single sheets of gold, these seamless cups for corn beer were hammered over one or more wooden forms in an arduous process of repeated working and annealing. The repoussé designs were pressed in from the outside with a soft, blunt tool, possibly over a carved wooden form held against the inside of the cup. Photograph by Don Meyer.



such; they only prize it when it has been worked by a craftsman into some form which pleases them."

Modern scholars of metallurgy in the Antilles have to rely primarily upon contemporary documentary accounts to evaluate the technology employed by native craftsmen. For the mainland of Central America, the position is less bleak, for some objects have survived, although documentary accounts remain of value. Gonzalo Fernández de Oviedo, the official historian of the Indies who served as overseer of smelting in the isthmus of Panama in the second decade of the sixteenth century, wrote admiringly of native craftsmanship there:

"The Indians work gold, and are accustomed to mix it with copper or silver.... They employ this art with so much ability and excellence, giving such a high brilliance to the things they gild, that they seem to be made of pure gold of twenty-three karats or more.... This is done using certain herbs.... The Indians have showed me the herb they use, but I was never able... to extract the secret of this gilding process from them...."

The conquest of Panama and Costa Rica, where for centuries the natives had been producing jewelry by the method of lost-wax casting (described later in this article), brought remittances of gold to Spain to an early peak in 1511-15, primarily from the looting or bartering of these and other artifacts, and to a lesser extent from the exploitation of placer deposits by the followers of Vasco Núñez de Balboa. Thereafter, shipments rose steadily until mid-century, with the conquest in 1519-21 of Mexico and its vast quantity of gold objects. The penetration of the greater part of inland Colombia, despite its proximity to Panama, was deferred until the 1540s, primarily because the quest by sea for Peru and its treasures was conducted along the inhospitable Pacific coast rather than by overland penetration. Glimpses of Colombia's accumulated wealth in gold were secured, however, as early as the mid-1520s. Francisco de Jérez's 1527 account of Francisco Pizarro's second expedition down the Colombian coast described an encounter with coastal Indians near the modern frontier with Ecuador:

"They had many objects of gold and silver to adorn themselves and to barter...; these included crowns, diadems, belts, bracelets, leg armor, breastplates, tweezers, bells, strings and bundles of beads, mirrors embellished with silver, cups and other drinking vessels."

At Tumbes, in northern Peru, reached in 1528, Pizarro's men similarly "saw clear signs of the wealth that was ahead, finding many small statues of gold and



silver with hands, breasts, and heads."

The conquest proper of Peru, initiated in May 1532 with the march from Tumbes to Cajamarca of Pizarro's third expeditionary force, was rapidly followed by the capture of the Inca emperor Atahualpa at Cajamarca, the vain attempt of his subjects to provide a ransom of gold and silver, and in 1533 by the greatest melt-down of treasure in the history of Latin America.

Peruvian craftsmen had been working gold for at least two thousand years, and were masters of advanced hollow-case casting and of decorative techniques involving the use of soldering. Most of the gold objects that the rapacious Spaniards indiscriminately described as Inca were, in fact, the products of earlier civilizations, such as the Chimú, which had recently been absorbed into the Cuzco-based empire. Whereas most early Mexican goldware did not survive the conquest, a considerable number of Peruvian and Colombian pieces did escape because they remained hidden in desert tombs or isolated burial sites until this century. Those items that fell into the hands of Pizarro and his followers, no matter how beautiful, were simply melted down; they included the gold litter of the Inca emperor Atahualpa and the life-size gold and silver animals and plants of the sacred garden of the sun god in Cuzco.

The melting down of this ransom in

Alligator pendant, Palmar Sur, Costa Rica, 7 cm. (2.8 in.) long. Despite its heavy, solid appearance, this lost wax casting is hollow. It hangs tail downward from two suspension loops, one under each forelimb. Photograph by Don Meyer.

nine furnaces continued for four months in 1533 and produced for Pizarro's 168 men no fewer than 13,420 pounds of 22½ carat gold and 26,000 pounds of good silver. Even the simple foot soldiers each received forty-five pounds of gold and ninety of silver. Many retired immediately to Spain to spend the rest of their lives in luxury, and, by their example, to encourage thousands more to set out for the New World to make their fortunes. For those who remained in Peru, the subsequent march on Cuzco, reached in November 1533, revealed even more incredible treasures, all of which were lost forever to posterity. Pedro Sancho, who participated in the campaign, recorded in 1534:

"Truly it was a thing worthy to be seen.... Among other very sightly things were four sheep [i.e. llamas] in fine gold and very large, and ten or twelve figures of women of the size of the women of that land, all of fine gold and as beautiful and well-made as if there were alive.... These they held in as much veneration as if they had been the rulers of all the world,

and alive, and they dressed them in beautiful and very fine clothing, and they adopted them as Goddesses, and gave them food and talked with them as if there were women of flesh. These went to form a part of the fifth of H.M.... The Governor [Pizarro] divided and distributed all this treasure among all the Spaniards who were at Cuzco and those who remained in Xauxa."

From Cuzco, expeditions moved south to modern Bolivia and Chile, and north to modern Ecuador and Colombia, in the continuing but ultimately vain quest for native civilizations comparable in size and wealth to those encountered in Peru. The search for Eldorado—the legendary city of *el Dorado*, the Man of Gold, who could be seen shining in the light of the setting sun, standing in his boat before bathing in his lake and washing off the gold dust that covered his greased body—in 1538 drew Pedro de Candia and three hundred men into the appalling jungles of southeastern Peru, where half of them died; Gonzalo Pizarro, one of Francisco's four half-brothers, took a northeasterly route in 1542–43 in search of this same objective. Having taken to the river Napo to search for food, one group of his followers, led by Francisco de Orellana, were forced, primarily by their inability to return against the stream, to follow the entire length of the Amazon River to its mouth, finding



Arm Band, Inca, Peru, 2.5 x 6.2 cm. (10 x 2.4 in.). During the colonial period, Inca craftsmen incorporated European motifs into their designs. The gold armband with its European horseman set among native Peruvian animal figures is a fine example of this syncretism. © 1987 The Art Institute of Chicago. All Rights Reserved.

neither gold nor sedentary natives in the process. So vast were the areas bounded by the Amazon and Orinoco river systems, and so intense was the continuing Spanish desire to reach Eldorado, that the quest for gold continued to draw Spanish expeditions into the interior of northern South America throughout the sixteenth century. By the third quarter of the century, popular opinion had placed the fabulous city somewhere in the highland region between the Amazon and Orinoco valleys. Like the equivalent belief in Mexico in the legendary seven cities of Cibola—in reality the humble dwellings of the Pueblo Indians—the quest served only to push the frontiers of Spanish territory into inhospitable territories, in this case Guiana, which would otherwise have been left to other colonizing nations.

The more far-sighted settlers had realized by the 1540s that the bonanza of native gold was over, and that in the future bullion would be provided not by traditional barter and looting, but by the development of the mining industry.

Peru and to a lesser degree Mexico were to become significant producers of placer gold by the middle of the sixteenth century, as were Chile and modern Colombia somewhat later. However, as early as the 1530s the volume of silver shipped to Spain had been seven times that of gold, and, following the discovery of fabulously rich silver deposits at Potosí (in modern Bolivia) in 1545 and at Zacatecas (Mexico) in 1548, it became clear that silver rather than gold mining was to become the basis of economic life in Spanish America. The relative importance of the two metals is starkly indicated by the estimate that between 1500 and 1650 registered trade conveyed 181 tons of gold and 16,000 tons of silver to Spain from her American colonies.

Even when allowance is made for the greater value of gold—the ratio in the sixteenth century between the two metals was usually one to ten—it is clear that after 1550 silver had become the key to the commercial relationship between Spain and its American empire.

Native Technology before the Spanish Conquest. The basic metals used by Indian jewelers before and during the Spanish conquest were gold, copper, and silver, although in some areas tin was added to copper to produce a true bronze, and the metalsmiths of the Pacific coast of Colombia and Ecuador had discovered how to work the platinum that occurs

naturally in the gold-bearing gravels of the rivers of that area. The three principal metals were used in their pure forms, but were also combined into alloys of various colors and hardnesses. In Peru and Ecuador, where silver production always outstripped that of gold, much ornamental jewelry was made of a ternary alloy of silver, copper, and gold. Further north, in Colombia, Mexico, and the Isthmian countries, the most common material was *tumbaga*, the gold-copper alloy described by Oviedo, which melts at a lower temperature, and is therefore easier to cast, than either of the pure metals alone.

Historical documents of the sixteenth century suggest that hammering and casting were regarded as two distinct trades, each with its own special skills. Although both techniques were employed throughout Latin America, there were clear regional preferences. In Peru the fashion was for large showy items made from sheet metal (masks, head-dresses, vessels, and wooden objects covered in gold); to the north, from Colombia to Mexico, the finest work was cast, smaller in size than the Peruvian pieces, but more delicate in quality.

Workers in sheet metal used anvils and hand-held hammers made of hard, fine-grained stone. In Peru these hammers were described as being "like dice with rounded corners," but in Caribbean Colombia the early Spanish documents



refer to hammers "the size of eggs or smaller" and "anvils the size of a Mallorca cheese." Examples of all these tools have been found archaeologically. Pure gold is soft and fairly easy to beat, but under continuous hammering many of its alloys become brittle, with a tendency to crack. Malleability was restored by annealing, replacing the item in the furnace until the metal glowed red, then quenching it in water. By these means Peruvian metalsmiths were able to produce sheets that had a thinness and evenness that compare with the modern industrial product.

The techniques used to manufacture sheet objects were fairly simple. The metal was cut out with a chisel (for shears were unknown), then further decorated by chasing or embossing. Cups and beakers were "raised" by hammering and turning a disc of metal over a wooden form, and design motifs were added by pressing the sheet over convex models or into concave dies. Multi-piece objects were made by joining several previously shaped pieces of metal by means of hammer welding, soldering, pinning, or stapling, or else by clinching, in which the edges to be joined were overlapped, folded together, and then hammered down. In Peru, especially in the far north, bimetallic objects (nose-ornaments, diadems, ceremonial knives) were produced by welding together gold and sil-

An illustration from Friar Bernardino de Sahagun's sixteenth-century history of New Spain shows part of the process of lost wax casting in Mexico. The jeweler uses a furnace heated by charcoal, the draught being supplied by blowing through a cane or metal tube on the embers, on which rests a clay crucible.

ver elements. Hammered gold foil, or thin gold leaf, was also laid over base metal or wooden items such as staffs, trumpets, and ceremonial litters.

Throughout America the most complicated and delicate pieces were made by casting. The jeweler used a furnace or brazier heated by charcoal, the draught being supplied by blowing through a cane or a metal tube into the embers, on which rested a clay crucible. Simple, open molds of stone or terracotta were used for casting flat objects such as axes or chisels, but the casting of three-dimensional pieces in multi-piece molds was never popular in the New World outside Peru, where little figurines were made by using piece-molds of up to thirteen separate elements. Instead, most American metalsmiths preferred their *cire perdue*, or lost wax, method of casting.

For hollow objects such as figurines or pendants, which sometimes had movable parts, the goldsmith first made a core of powdered charcoal mixed with clay.

Once dried, this was carved into shape and over it was laid a sheet of purified beeswax. Any additional carved or modeled detail was added at this stage, before the outer casing was put on. The wax was covered with a slurry of powdered charcoal and water, to ensure a sharp casting, and this in turn was enclosed in a thick covering of clay. Wooden pegs held the core in position so that it did not move during casting, and vents were left in the outer casing to allow gases to escape. After drying out, the whole thing was heated so that the wax melted or vaporized, leaving a space between the core and the outer covering. While the mold was still hot, molten metal was poured in, filling the space left by the melted wax and giving an exact metal copy of the wax original.

Many objects seem at first glance to have been made by the filigree process in which metal wires are rolled or twisted, then soldered together or attached to a backplate. Laboratory analyses show, however, that nearly all these pieces are made by a "false filigree" technique and were, in fact, manufactured by lost wax casting. Wax threads, which give the appearance of metal wire, were used to build up a single-piece model that could then be cast in the normal way, in one operation. The fan-shaped ear ornaments from the Sinú region of Colombia are some of the finest examples of this technique.

Because the mold has to be broken open to extract the cast, each item is a unique creation and no two are exactly alike. This makes it difficult to produce sets of identical pendants or necklace beads, but the Muisca goldsmiths of Andean Colombia solved this problem by using stone blocks, or matrices, with designs of figures, animals, and geometric motifs carved in high relief on all faces. From these matrices were made mass-produced wax models, all identical, that could then be cast by the usual lost wax method.

Many ornaments with a golden surface turn out to be made of *tumbaga* with 80 percent or more of copper. The jewelers of northern Peru had discovered how to produce a very thin gold or silver surface by a process of electrochemical replacement, but elsewhere the metalsmiths employed a form of "depletion gilding" in which the alloy was heated and pickled in an acid plant juice or a solution of corrosive minerals, which removed much of the base metal at the surface but left the gold untouched. This created a gold-enriched surface, which had to be polished or burnished in order to consolidate the surface layer of gold and to give a shiny finish.

Native Metallurgy after the Spanish Conquest. Despite the ferocity of the Spanish conquest in the half century



after 1492, it did not bring a sudden end to indigenous metallurgy or many other traditions. Outside the major cities founded or taken over by the conquerors, the European presence was slight, and Indian communities maintained many of their old ways for more than a century after the initial contact. Some of the less accessible regions, or those where Indian resistance was most stubborn, remained effectively independent. The Taironas of northern Colombia, for example, in the rugged terrain of the Sierra Nevada de Santa Marta, maintained trade contacts with the Europeans of the Caribbean coast from the 1500s onward, but were not finally pacified, even superficially, until 1600.

In metallurgy the indigenous and European traditions coexisted, with various degrees of merging and blending, well into the colonial period. Venetian glass trade beads were incorporated into necklaces of pure native style; Spanish iron axes, knives, and scissors were buried in Indian graves alongside gold

jewelry of pre-hispanic type; motifs borrowed from European art were incorporated, often quite incongruously, into Indian designs. The gold armband seen on pages 22–23, with its European horseman set among native Peruvian animal figures, is a fine example of this syncretism.

The colonial administration was not concerned with jewelry fashions among its subjects and made no attempt to prohibit the use of ornaments in native style. The Catholic Church, however, could not allow the representation of "devils" and "heathen images," still less the offering of golden items to the old gods. The many reports of this period dealing with attempts to suppress Indian idolatry give valuable information about the ritual use of gold and also show how difficult it was to eradicate the native religions.

One such report, for the year 1577, describes the visit by a certain Diego Hidalgo de Montemayor to the Muisca communities of the province of Tunja, in

A representation by sixteenth-century Flemish engraver Theodor de Bry showing a Guianan nobleman being covered in gold dust, blown through a pipe by a retainer to the right.

the Eastern Cordillera of Colombia, in order to collect and destroy the images (*santillos*) offered in clandestine shrines. These sanctuaries, identical to those in use before the arrival of the Spanish conquistadors, consisted of small, dark huts made of wood and straw, poorly ventilated, and black with the smoke of incense. Inside were the idols and the votive offerings—uncut emeralds, marine shells imported from the Caribbean coast, wooden items, and miniature images (*tunjos*) of gold, copper, and *tumbaga*—wrapped in cotton cloth and stored in jars or enveloped in mantles. Hidalgo noted that many of the Muisca lords still employed metalsmiths whose duty was to make these images; as late as 1595, one of these men was found



De Bry's view of Panamanian Indians piling gold at Vasco Nuñez de Balboa's feet. Said one chief, who befriended Balboa, on seeing the Spaniards quarreling over gold that he had brought, "I am not a little surprised that you Christians make so many difficulties about so vile a thing, as if it were good for eating or drinking. But since you have such a desire for this metal, I will lead you to a place where you may all satisfy yourselves with it."

to be still using a set of typical pre-Spanish matrices inherited from his metalsmith father.

In the cities of the Spanish empire styles and fashions changed more rapidly, as Indian craftsmen began to work for European patrons, but in technology the Indian metalsmiths had nothing to learn from the conquerors. In his description of colonial Aztec jewelers, the Spanish friar Toribio de Montolinía, one of the original twelve Franciscans in Mexico, makes this quite clear:

"...they could cast a bird with a movable tongue, head, and wings, and cast a monkey or other monster

with a movable head, tongue, feet, and hands, and in the hand put a monkey so that it appears to dance with it; and even more, they cast a piece one half gold and one half silver, and cast a fish with all its scales, one scale of silver, one of gold, at which the Spanish goldsmiths would much marvel."

This seems to have been the general opinion among the European artists of the period. Albrecht Dürer was not the only one to admire the items sent back from Mexico by Cortés, for Benvenuto Cellini (one of the finest goldsmiths of his day) tried, it is said, to copy one of these bimetallic pieces, but had to admit defeat.

Postscript. Silver and to a lesser extent gold objects, manufactured after the conquest for Spanish consumers, are relatively commonplace in Latin American and European museums and private collections. Pre-Columbian objects of the contact period are much rarer because most of the small number of pieces that escaped melting down in America went into the melting pots of Europe. By

the end of the colonial period, therefore, few items had been deliberately retained. In the late nineteenth century, some four hundred years after the initial conquest, a new wave of pre-Columbian gold objects, found in tombs by amateur and professional treasure hunters, were again being melted down, now by bullion dealers in London and New York. Fortunately, a significant number were rescued by private collectors and public museums to form the basis of modern collections of ancient American gold, supplemented in recent years by items from archaeological excavations. Despite all the odds, enough gold objects have survived to provide the twentieth-century scholar and public with a glimpse of the extraordinary metallurgical skills of native American jewelers before, during, and after the Spanish conquest.

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THE QUEST AND THE RUSH: From Brazil To Alaska

by DONALD CHAPUT



Despite the riches garnered during the Spanish conquest, and persistent myths to the contrary, Mexico actually had very little gold. True, the Cortés plunder was spectacular, but this treasure represented the accumulation of generations. Central and southern Mexico were actually poor in amounts of placer (sand and gravel deposit) gold. By the eighteenth century, Mexico would evolve into the world's

leading silver producer, but gold only became important in the nineteenth century when the Sonoran fields were located. The Inca lands, however, were indeed rich in gold deposits, and for three hundred years Spain would continue to wrest the yellow metal from the mines of Chile, Peru, Ecuador, Venezuela, and Colombia.

From the first years after discovery, and well into the twentieth century,

A map, Novus Orbis sive America, by Matthäus Seutter (1678-1757), shows the New World.

Spanish America has provided many important gold fields. Only a few locations, such as Argentina and Uruguay, have not had major strikes, and Bolivia has the glory and problems of silver and tin. The former coastal Inca countries have seen many huge mining developments. In the eighteenth century Chile had its golden age, and Ecuador, Peru, Colombia, Venezuela, and the Guianas to this day have working gold mines. In Panama, Honduras, and other Central American locales, men have extracted millions of dollars worth of the yellow metal over the last two hundred years.

Mexico, famous for silver production, had important gold finds in the nineteenth century in Sonora and Baja California. Northwestern Sonora miners, because of their experiences in the 1830s and 1840s, were the first talented miners to reach the California gold fields in 1848–49. In the 1870s and 1880s Baja California gold rushes of note, Real del Castillo in the early 1870s and El Alamo in 1888–89, had an impact on Mexico and California. The modern port city of Ensenada owes its prominence to these mining efforts. The success or failure of hundreds of these Mexican mines were related to available and often very limited water supply, and some of the most effective techniques were based on dry-washing, using air instead of water to separate the gold from the sand.

Brazil dominated world gold production in the 1700s. This thinly settled Portuguese colony was on the brink of financial disaster in the 1690s when gold was discovered in Minas Gerais, some two hundred miles northwest of Rio de Janeiro. The placer deposits were found by the Paulistas, mixed-blood frontiersmen from São Paulo, who opened much of southern Brazil. Allegedly, the discoverers had been seeking another Potosí (in Bolivia), the world's richest silver mine.

Miners and settlers poured in, and thousands of slaves were imported from Africa to work the new placer and lode deposits. In the next few decades there were at least four other major strikes in Brazil, the largest in the hinterlands of Salvador, in the state of Bahia. Salvador became the largest slave-trading center in the world in the effort to wrest the gold from the land. Tiny Portugal owned the world's richest gold mines.

What happened to the Brazilian gold? Maybe as little as half of it reached its destination in Portugal. By 1695 the system of "fifths" was inaugurated in Minas Gerais. Miners were to turn in all gold to four smelting houses, later to the Rio mint. Bullion bars were numbered, seals struck, and then one-fifth was cut off for the crown. The owner was then at liberty to sell the gold to anyone, except foreigners.

Brazil became the world's gold-

smuggling country par excellence because, naturally, many miners sold their gold before going to the mint. For over a hundred years government leaders, port officials, landowners, ship captains, and priests sliced away at this golden harvest. The thousand-mile coastline of Brazil was impossible to police. Much pilferage also occurred even after the gold reached Portugal. For example, during the eighteenth century, London newspapers regularly reported the receipt of Brazilian gold, although not an ounce of it was legally obtained. One estimate of 1705 was that Minas Gerais produced 32 pounds of gold each day. For the year, the crown should have received 1 million cruzados; instead, only 20 percent of that reached the royal treasury.



Because of British interest in Latin American mineral development, much mining equipment was imported from England or the continent. The good luck rooster lamp, manufactured in Germany or France, held an oil wick, and was used in Bolivia in the late 1800s. Photograph by Dick Meier.

Despite pilfering and the crown's share, many reminders of this golden past are to be seen in Brazil. The architecture of many churches and public buildings in Bahia and greater Rio show profuse use of heavy, lush gold leaf work, and at least ten museums, including the Gold Museum in Ouro Preto, Minas Gerais, have outstanding collections of decorative pieces and jewelry made of Brazilian gold. The rich collection of the Imperial Palace Museum in Petropolis is further evidence of the beauty and significance of Brazilian gold.

The early 1800s saw a diminishing output in Brazilian mines, and Spanish-American production suffered even more severely. The era of revolution and independence ended Spain's rule by the 1820s. However, the freeing of the slaves, and the neglect of the mines, meant rust-

ing machinery and collapsing buildings. Priorities were elsewhere, and production fell to perhaps half of its pre-revolutionary totals. The New World mines had supplied most of the world's gold and silver during more than three centuries of colonial rule; new sources were eagerly sought.

Aside from smuggling, New World treasure disappeared in other ways: shipwreck and piracy. As danger from storms and enemies increased, the Spanish treasure flotilla evolved; the first squadron was dispatched to the New World in 1537. After 1564, separate fleets sailed from Spain each year, one to Mexico, the other to Panama. The fleet would distribute goods; pick up gold, silver, and other merchandise from Mexico, Central America, the Spanish Main, and the Caribbean islands; meet in Havana; and then take advantage of the currents and sail home to Spain via the Florida Straits. Sometimes dozens of merchant and armed vessels made up the fleet. By 1600 the smaller caravels were being replaced by galleons, multi-decked warships that were faster, longer, more heavily armed, and possessing a greater capacity for transporting treasure and an armed crew.

The Spanish concern for the treasure fleet was justified. In addition to dozens of solitary vessels that disappeared without trace, there were also other causes for alarm. An English force attacked treasure vessels off the coast of Spain in 1702; an English squadron destroyed a Spanish fleet off the Spanish Main (Cartagena) in 1708; a severe storm wrecked a fleet off Cuba in 1711.

One major disaster involving a fleet consisting of eleven Spanish vessels and the French ship *Griffon* occurred in 1715. Total treasure registered, mostly gold and silver, was almost \$100 million in present value. On July 31, a violent hurricane smashed the fleet as it sailed the Florida Straits. Over a thousand men were killed, and all ships except the *Griffon* were ruined. In the three following years a Havana team salvaged some of the treasure, but much was to remain in Florida waters until discovered in 1964.

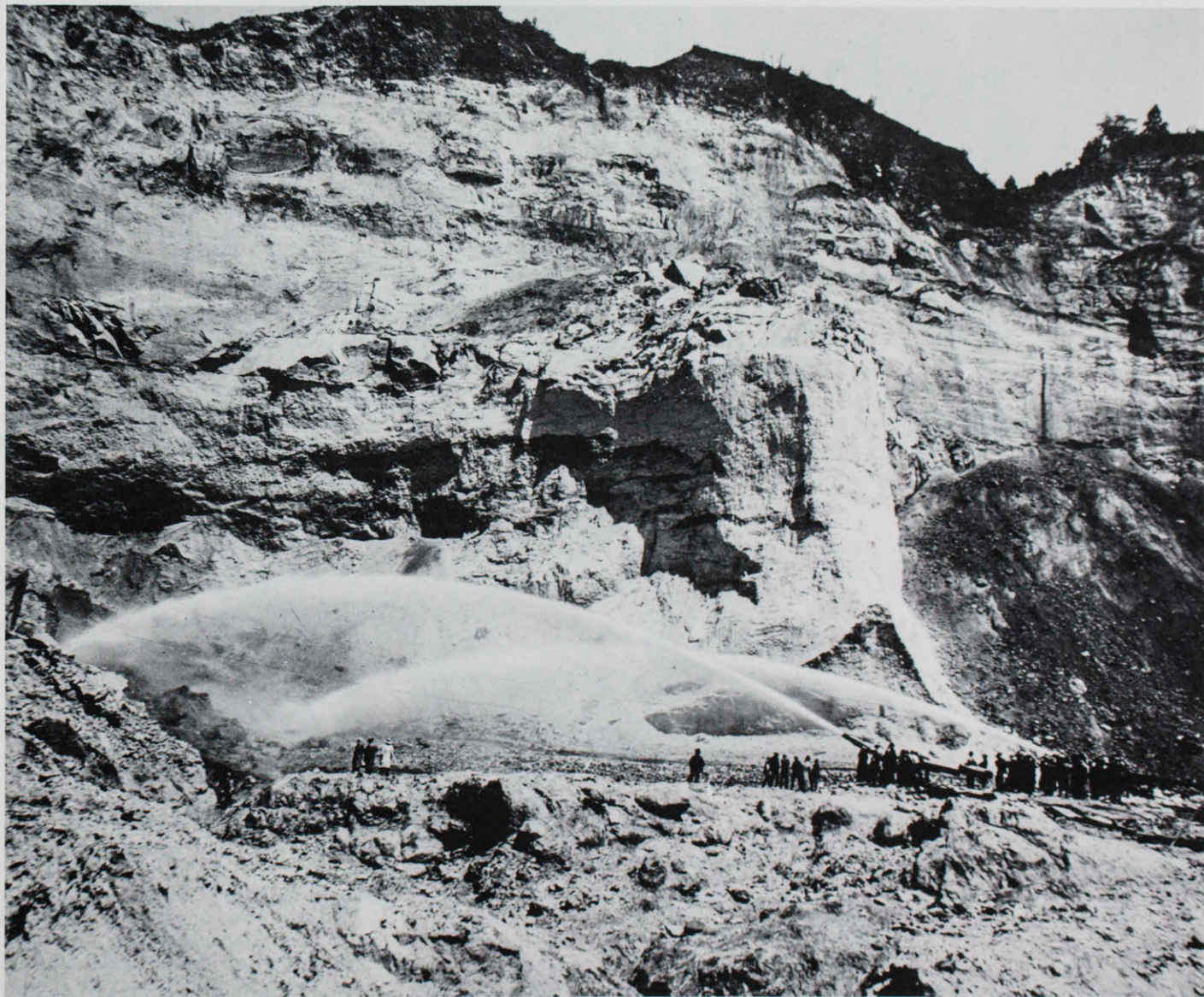
On July 15, 1733, another Cuba-Spain fleet of nineteen ships was battered by a hurricane off the central Florida Keys. All vessels were sunk, smashed, or grounded. The Havana salvage crew, though limited to lung power, was able to salvage at least 12 million pieces of eight.

The classic of shipwreck-treasure study is that of the *Nuestra Señora de Atocha*, a galleon, part of a fleet of twenty-eight caught in a hurricane off the Dry Tortugas in 1622. The *Atocha* had a crew and 48 passengers, and part of her cargo was 901 silver bars, 161 gold bars, and 255,000 silver coins. When the vessels were destroyed by the hurricane, almost 600 men died. The *Atocha* treasure was located in the 1970s by deter-



The California gold fields, and especially the main port of San Francisco, became host to thousands of newcomers, not only from the eastern United States, but from Europe, South America, Asia, and Australia. This scene shows Chinese miners, who were among the most numerous and significant groups in San Francisco.

Hydraulic mining emerged in the early 1850s and involved shooting pressurized water against mountain gravels. This type of large-scale placer mining spread throughout the Mother Lode counties of California, and if water was not available in gold-rich areas, rivers were created by building wooden flumes capable of carrying water dozens of miles. Protests from farmers and conservation groups forced the passage of the Anti-Debris Act of 1882, severely limiting the type and degree of hydraulic mining. Photograph courtesy of the California Department of Parks and Recreation.





mined salvager Mel Fisher, who enlisted historian Eugene Lyon as a researcher. Dedicated research in Spanish libraries and archives with manuscripts, journals, and maps enabled Lyon to pinpoint the location, and the subsequent success has been the world's most fabulous salvage operation.

Much treasure was grabbed by buccaneers or poachers, later known as pirates, who evolved from an assortment of criminals, escaped slaves, and outcasts in the Caribbean in the 1500s. Their names were as exotic as their careers: Rock Brasillano, Bartolomew Portugues, Francis Lolonois, Blackbird. Their plundering success led to easy recruiting, and some groups operated many ships and had land forces capable of besieging coastal cities. How much gold, silver, women, and other spoils were carried off in their raids can only be conjectured, but it must have been substantial. Some historic figures, such as Sir Henry Morgan and Sir Francis Drake, for much of their careers were really pirates. In later years the term "privateer" was used to describe a vessel that unofficially had a country's blessing to plunder vessels of another flag; piracy better described their actions.

Gold in the North American West.

Prior to the California Gold Rush, the United States did produce some gold in Georgia and North Carolina, and miners from those states shifted some of their knowledge and technology to the American West. But it was the discovery of gold in California in 1848 that led to the first frenzied "rush," one that would influence subsequent mass moves of people to the gold strikes of Australia, British Columbia, Colorado, Montana, and Alaska.

John Marshall's discovery of gold near Sacramento in 1848 changed California from a thinly populated, newly conquered territory into a state of the union in two years. Tens of thousands of people from all continents headed for the gold fields, which in the early days were the streams and gullies on the west side of the Sierras that flowed toward the Pacific Ocean. The Feather, Trinity, and Yuba rivers marked the northern boundaries of these rich placer fields, and the Mariposa River defined the southern edge.

The first phase of the California Gold Rush, lasting roughly from 1848-51, was characterized by miners working the sands in rivers and on the beaches. Taking advantage of gold's high specific gravity, the miners worked the sands using rockers, long toms, sluices, and other devices, moving the water, sand, and pebbles along while trapping the heavier gold. This kind of mining was pursued by an individual or small groups of workers.

The richest material was soon taken in these placer workings, but the mother lode was soon located in 1849-50, and





Page 30, left: John Sutter is one of the best-known characters in the history of the American West. This Swiss immigrant moved to Mexican California, where by the late 1830s he owned considerable land, was a local merchant, and had established Sutter's Fort near Sacramento. In 1848, early in the American regime, gold discovered at his mill at nearby Coloma led to the most famous of gold rushes. This magnificent

portrait of Sutter, painted by William S. Jewett, captures him in his uniform as a major general in the California militia. Photograph courtesy of the California Department of Parks and Recreation.

Page 30, bottom: The gold rushes of Alaska and the Yukon received considerable publicity, attracting novelists, poets, and moviemakers. The Trail of '98 was produced in 1928, near the end of the silent era.

Above: This oil and gold on canvas painting was created by Luis Niño, a Peruvian Indian, in the 1730s. Our Lady of the Victory of Málaga shows European and local Indian influences in the rich ornamentation and the subject matter. The gold is built up, encrusted, and contoured rather than applied in the usual flat fashion. Photograph courtesy of the Denver Art Museum.



The most impressive modern gold rush is taking place in Brazil, at Serra Pelada, not far south of the Amazon. The Brazilian government has opted to permit the ground to be worked only by individuals and small operators. As a result, hillsides are swarming with thousands of men and boys as they carve, carry, and wash away the mountain sides in the quest for the yellow metal. Photograph by Harald Martes.

hardrock or quartz mining got its start, particularly in Mariposa and Nevada counties. Large investments, big machinery, and many men were needed in these new operations. The 1850s also witnessed the birth of hydraulic mining, where gravels of entire mountain sides were washed away in the search for gold.

Mining engineers altered the courses of rivers and built flumes to carry water ten or more miles. By 1860 the romance had long since withered from California gold mining, but the shaft, hydraulic, and other large-scale forms of alluvial mining were producing more gold than ever.

Sizable libraries have been accumulated on the history of man's quest for gold in California. The publications of the day provide the reader with a sense of the awe, the adventure, and the attraction the Golden State exerted on would-be prospectors ten thousand miles or more away. Newspapers, posters, sheet music, company stock promotions, ship sailing notices, geological reports, travelers' guides, and magazine articles all spread the allure of California gold. Letters back home, diaries, and journals

were some of the more personal ways that word of gold was dispersed.

California is today the nation's most populous state and one of the richest regions of the world; the Gold Rush cities of San Francisco, and Sacramento are important financial, governmental, and cultural centers. There are many reasons for California's success, such as mild climate, a multitude of natural resources, and a face on the Pacific. Yet, the initial Gold Rush, that infusion of people and spirit, formed the underpinning for much of the state's later growth and success.

The California success story was not always repeated. A gold rush on the Arizona side of the Colorado River in the early 1860s led to a few rich years, but not a trace remains of the boom towns of



Ehrenberg and La Paz, the latter for a few years the seat of Yuma County. At the turn of the century in western Nevada the boom towns of Tonopah, Goldfield, Rhyolite, and Belmont enjoyed a decade or so of wealth based on the yellow metal, but few evidences of prosperity remain.

"Pike's Peak or Bust!" the cry of 1859, heralded a gold rush that greatly affected the growth of Colorado and the city of Denver. Nearby success at Cripple Creek in the 1890s was just one of dozens of Colorado mining bonanzas, which initiated the Rocky Mountain state's century-long production of a variety of precious and base metals.

The Homestake Mine in South Dakota, which started production in 1878, never had the romance of other great

mines, yet it outproduced them all. Homestake ores, excavated from mines located near the town of Lead, were unusually tough, and from the beginning large machinery and expensive techniques and explosives were needed. Individual prospectors or miners never had a chance here, yet the gold ores were so rich that the Homestake remains North America's leading gold mine.

On to the Frozen North. Alaskan gold had been known for years, but the first big rush resulted from the Klondike-Yukon finds of 1897-98. Seattle became the jumping-off and provisioning center, and soon names such as North West Mounted Police, Yukon, Skagway, and Chilkoot Pass became known worldwide. Jack London, Joaquin Miller, and other literary figures have left memorable stories of these Alaskan-Canadian mining frontier days. Later finds in the Nome-to-Fairbanks region in 1899-1901 meant further success and wider publicity for Alaskan gold.

Dredging, another type of placer mining, evolved at this time. Although dredging had been tried near Marysville, California, in the 1850s, the technology and investment backing only became available in the 1890s, based mostly on Australian and New Zealand experience. By the early 1900s California was in the forefront of dredging, with huge operations taking place on rivers in the northern part of the state. This California experience was soon modified for use in colder climates, and California dredge consultants were prominent in devising special machinery and methods for use in Montana, Alaska, and Siberia.

It was first necessary to thaw the ground to work the frozen gravel deposits in Alaska. Pipes, called thaw points, were driven deep in the tundra and hot water forced down, which then circulated back to the surface. When a large enough area had been treated, dredging or other types of placer mining could take place.

The Present, The Future. Although hydraulic mining has long been outlawed or restricted because of environmental considerations, much of the gold mined in the American West is still garnered by traditional hardrock and placer methods. The main shift in the 1980s has been to heap leaching, a system of working low-grade ore with a weak cyanide leaching process. In the Serra Pelada of Brazil, the century's most frenetic mining is taking place with the oldest of methods: thousands of men are ripping apart hillsides and working the sands with water for the yellow metal.

From the Aztecs and Incas to the Yukon prospector, to the Brazilian at modern Serra Pelada, a notable feature of the quest for gold is man's constant de-

termination. If men need to be killed for it, so be it; therefore, Spaniards slaughtered thousands of Indians in the cause. Distance? Not a factor, as the California gold fields were worked by thousands of Chinese, Frenchmen, and Chileans. Mountains? Wash them down with hydraulicking. Lack of water? Make new rivers, from a score of miles away if necessary. Too cold? Thaw the ground, then work it. Gold specks too small to be seen? Amass huge quantities of low-grade ore and use cyanide to recapture the gold. So far, nature has not been able to prevent men from seeking, finding, and using the yellow metal. As the quest continues, so is it being rewarded.

Donald Chaput is a curator in the Natural History Museum's History Division with responsibility for the mining collections.

A nostalgic account of the Gold Rush experience:

In Camp—1849

*All day we worked beside the sluice
With pick and pan, and spade and rocker;
And left our purses lying loose,
And never dreamed of safe or locker.*

*And so we worked with jest and song,
And reckless threw away the "tailings,"
And rocked the "cradle" all day long,
But never heard an infant's wailings.*

*And when the busy day was done,
And night unveiled her starry glories,
We gathered slowly, one by one,
Around the fire, to hear the stories—*

*How "Greenhorn Gulch" was panning out
To every man a hundred dollars;
And "Jake" and "Greeny" went about
With "white biled" shirts and stand-up collars;*

*How Jenkins struck it awful rich,
(The same that had that pretty daughter),
And thought he'd have to dig a ditch
From "Wild-cat Run" to fetch in water.*

*How "Texas Bill" and "Irish Pat"
Were ever all the rows and shoots on;
And gambler Hill, of "Brandy Flat,"
Passed in his checks, and dead with boots on.*

*How "Frisco Kate" and "Hangtown Sal,"
Danced at the ball with roughs and bumsers;
And how old Simpson's red-haired "gal,"
Threw off on spooney Charley Summers.*

*And then someone discussed about
Dick Ropes, who tied to Susie Keller—
She "sized" his "pile," and cleaned him out,
And left him for another "feller;"*

*And he, poor fool, took on and cried
All night, and in the morning, Sammy,
A bullet hole found in his hide,
And he all stiff and cold and clammy.*

*And so the night hours waned and crept,
Until our eyes grew dim and weary,
And each his blankets sought, and slept,
To dream, perchance, of Belle, or Mary.*

*O glorious days! O dazzling gleam
Like meteor's glare upon the river;
Bright vision fled! O golden dream!
Like rainbow seen, and gone forever.*

Albert F. Kercheval (1883)

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